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ACROSS THE SANTA BARBARA CHANNEL.

BY J. WALTER FEWKES.

(Concluded from the April Number.)

ON our return to the "Angel Dolly" we found that our cook had prepared a most delicious dinner on shore. We had roast leg of mutton, cooked on a spit, abalones fried and stewed, and coffee. The abalones we collected everywhere on the shore. The animal was cut out of its shell, pounded until tender in an Indian mortar, and then fried in batter. The taste of these animals, after our row in the open air, was fine, but it is doubtful whether we would have eaten the abalones with the same zest under any other circumstances. We ate our dinner under an overhanging roof of rock in a partially formed cave, the floor of which was the shingle of the beach of the cañon. I was reminded of the times when wild men did the same, probably in the same cave, as the abundant shell heaps and inscriptions show that they undoubtedly did. On the roof of the cave there was noticed a curious product of the erosion of the rock, such as I have never seen before. In the mass of conglomerate there is a pocket of grayish rock projecting from the surface and worn into cells, the edges of which stand out in sharp relief. These cells, not unlike honeycomb in form, are rounded, smooth, and several inches in diameter. The edges of the cells are sharp and smooth. The mode of formation of this curious pocket is not clear to me. It is a mass of rock several feet in width, and was formed on the roof of the overhanging conglomerate under which we ate our dinner.

In the afternoon we tried collecting on the black reef, which partially breaks the sea from Star Cañon on the east. I found the sea very high on the reef, but on the lee side a few good things were found. We noticed that the rocks on the seaward side were covered with mussels, among which were a few sea-urchins and beautiful starfishes. The bottoms of the pools in the reef were covered with Zoophytes which, when fully expanded, made them look like flower beds. Among them were several large Anemones of the genus Bunodes, and many Serpula. Many of the Actinians were over a foot in diameter when fully expanded. The rock which composes the reef is a black asphaltic formation, similar to the embedded rock of the conglomerate on the shore.

We returned to the "Angel Dolly," and found the cook had caught two large fishes known as Garibaldis, which with "crawfish," Panulirus, were served for our supper on board the schooner.

The mainland of Santa Barbara looked dim in the distance as I walked the deck after supper, but the sky above us was clear, and I watched the evening star, Venus, sink below the top of Monte Diablo. It was a very beautiful sight. The air was calm, and there was but a slight swell on the surface of the Channel, which had an almost glassy calm. I was, however, tired out by my experiences, had a good night's rest preparatory to new exploration on the morrow.

On the next morning we concluded to take the "Angel Dolly" up to Prisoner's Harbor, several miles to the eastward of Star Cañon. I thought the best way for me to study the cliffs was to follow in a boat, letting the schooner work up under sail. This seemed more expedient, since the Harbor was exactly to the windward, and there seemed indications that the winds would be light. and perhaps it would be impossible to sail near the coast. The wind, however, freshened considerably after we started, and the "Angel Dolly" worked far ahead, standing out into the Channel. There was a heavy swell throwing high breakers on the cliffs.

Wherever we landed in our trip we were obliged to beach the boat through the breakers, and we were often plunged to our waists in water in landing. Just to the east of Star Cañon, after rounding the black ledge which was my collecting ground the day before, we coasted along past the "Indian Cemetery," from which many Indian remains have already been gathered, and in which many more are still buried. There seemed to be two separate regions of shell heaps, although the whole coast in this vicinity is white with the shells and debris of the camps of bygone times. In these burial grounds the individual graves were formerly indicated by the ribs or lower jawbones of whales set in the earth above them. None of these now exist, and these shell-heaps have long ago been dug into by eastern collectors. The shell-heaps were not wooded, but here and there are large patches of the prickly pear or "Tunis," and flocks of sheep now graze over the graves of the former lords of the island.

We continued our row past the Indian Cemetery to a natural archway, eroded by the sea, formed by a projecting cliff, on each side of which there is a deep cañon with precipitant cliffs on either side. The cliffs of these cañons are possibly 200 feet high, and so abrupt that they seem almost perpendicular. These natural archways rival in size the famous *Arco Naturale* of Capri, and are among the most instructive instances of erosion on the Californian coast. Of two fiords separated by the cliff of conglomerate, one which we may call Southeast Cañon has a long, narrow entrance, and is stopped up at its entrance by large boulders, which prevent access to the cañon. There is, however, a small, gravelly beach at the mouth of this cañon, upon which we landed. On the right, as we entered, there is a picturesque natural archway, with an old Indian fireplace perched upon it. There are a few pines and wild flowers growing from the crevices in the cliff. A buttress which divides the two fiords from each other is composed of conglomerate. On the right and left are slates in stratified masses, and red colored rocks, the conglomerate above the slates.

From these two cañons we made our way to Prisoner's Harbor, and after some difficulty boarded the "Angel Dolly," which came up soon after.

Without anchoring, for a considerable sea had arisen, we continued to the eastward of Prisoner's Harbor to a point opsite Chinese Harbor, and cast our anchor in smooth water near shore. The rocks at this place differ greatly fom those at Star Cañon. Here we find variegated formations forming white, chalk-like cliff much eroded, and very different from the black, asphaltic rocks of the region to the west of Prisoner's Harbor.

The hills about Chinese Harbor are white and red, and show marked terraces of elevation. At their base there is a continuous beach, made up of small stones and shingle. On the side of the cliff are many bushes, but no trees. The collecting on the beach gave me many mussels, abalones, and a few starfishes. The sea near the beach is turbid with sand, reminding me of the white water of the Florida Reefs.

The hills about Prisoner's Harbor were clothed with verdure. There is a good wharf, and near it the warehouse and a cluster of buildings belonging to the company which owns the island. The hills near the landing place are not as high as those at Star Cañon, and resemble those to the eastward. It is this formation which is mentioned in the meagre accounts which we have of the geology of the island of Santa Cruz.

At Prisoner's Harbor I collected many interesting animals, among which might be mentioned a huge Nudibranch, Chioræa, allied to Aplysia, many starfishes, sea-urchins, and molluscs. Here also I found the interesting Helix,[1] said to be peculiar to the island. One of the most interesting genera of Annelids collected on the rocks near the half-tide mark is the well known Sabellaria. Sabellaria on the Pacific coast builds a thick mass of sandy tubes cemented together, forming on the rocks an incrustation of great thickness. At Punta del Castillo near the end of the beach at Santa Barbara great masses of these colonial worm tubes can be seen, forming a honeycomb structure on the rocks left by every retreating tide. Each worm tube when left out of water is closed by a circular operculum which effectually blocks up the entrance, forming a kind of door to prevent possibly the egress of water. By this simple arrangement the animal can live for a long time out of the water. A most interesting method of casting off the excrementa is also illustrated in this worm. The operculum is situated at the cephalic extremity of the animal, and as the masses of tubes are crowded together, the posterior extremity of the animal is brought to the blind ends of the tubes. There is, however, appended to this extremity a long tube, which, bending backward, opens near the open end of the case of sand. The vent of the animal is situated at the extremity of this tube and is thus brought to the surrounding water.

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[1] This species is rapidly being exterminated by the sheep, and in no short time will probably be extinct except in inaccessible cañons. Mr. Gulick records a like fate for certain Achatinellas peculiar to the Sandwich Islands.

Encrusting the rocks in several places we also found a moist deposit of sand of one or two inches in thickness, also closely connected with an interesting habit of another and different group of marine animals. Bunodes, a common Actinian of the southern Californian coast covers itself with a coating of sand, and when the tide falls the animal contracts its tentacles, and nothing is to be seen but this sandy deposit, concealing the body of the Actinian. In this way the genus lives between successive rise and fall of the sea, shielded under its coating of sand for hours, enduring great changes of temperature and the lack of the pure sea water. Colonies of these Bunodes were found many feet above the low-water mark. They also are common on the rocks of the well known headland, Punta del Castillo, and can without difficulty be observed by anyone who will visit this locality at low or half tide.

The island of Santa Cruz, as pointed out by Mr. Greene, has a peculiar flora which has many species not found on the neighboring continent, and genera which are only found in lands widely distant from it. It has also a peculiar species of Helix. In a word, although a continental island in its fauna and flora it reminds one of an oceanic island. Shall we interpret these facts by regarding it as a remnant of a continent or large body of land contiguous to California now submerged, or are other explanations to be sought? There is certainly not much to indicate an oceanic character to the Santa Barbara islands. Their peculiarity of flora can readily be explained by considering a change which has taken place in the climate of the mainland without affecting that of the islands. A change in the amount of moisture may have driven out the less hardy genera from the mainland, but left them still to survive on the islands. Moreover, a glacial period in California may have driven more hardy plants southward into a struggle with the less strong, in which the latter have succumbed. In a desiccation of the country the progress of the change would be less rapid on the island.

It seems to me that there is evidence that the island of Santa Cruz has lately been elevated out of the sea. This is the story of Ragged Mountain with its cleft summit, and of the elevated terraces to the west of Chinese Harbor. The deep cañons, however, show a much larger rainfall in the past when they were made than at present, and the enclosed asphaltic boulders standing out in the conglomerate are good indications of great erosion. The huge rocks blocking up the entrance to the cañons do not seem to have been brought there from the hilltops, but eroded by a mountain torrent on either side have simply dropped into the position which they now occupy. In most of these cañons the torrents which caused them have dwindled in size, although still large in the rainy season, while in many their beds are now dry during part of the year. If there ever was a glacial period on this island the tracks of it at present have been obliterated, or were not discovered in my superficial examination. There has been great erosion, but the boulders clinging to the worn side of the rock by one angle would seem to indicate that that erosion was by water rather than ice.

As we left Santa Cruz on our return trip we sailed through multitudes of a beautiful Velella, common in the channel at certain seasons of the year. These little blue sail-boats are often thrown up on the beach at Santa Barbara, and are common as far north as Monterey and San Francisco. Its northern limit is many miles north even of the limits of the state.

A curious little physophore, *Athorybia californica*[1] was also seen in the channel near Santa Cruz. This beautiful animal has never before been recorded from the Pacific waters of our west coast, although a similar genus has been described by the author from Key West and the Florida Keys.

The largest and most attractive of the Medusæ seen in my trip back was a mammoth Pelagia with mouth tentacles four feet long, and of a beautiful pink color. A lovely Hydromedusa, polyorchis, is one of the most common jellyfishes in these waters.

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[1] An account of the anatomy of this physophore is given in the *Annals and Magazine of Natural History.*

Perhaps the most interesting of all the Medusan denizens of the fiords of Santa Cruz is a small Hydromedusa, not larger than a small pea, which has this remarkable character. In place of clusters of tentacles about the margin of the bell it has but a single tentacle placed at the point of junction of the radial tube and the circular vessel. This single tentacle is a short, stiff appendage, exactly similar to one of the four tentacles of Dipurena, a genus found at Newport, Rhode Island. It is, in fact, as if we had a Dipurena with three of the tentacles missing and a single one remaining. In this Californian genus, however, there is but one of these curious, club-shaped, stiff appendages. A similar genus has never been recorded; to this species I have given the name *Microcampana conica.* The most peculiar structural character is found in the number of radial vessels in this jellyfish. All similar Hydromedusæ have but four, eight, or more radial tubes. There are some which have six, which however are not related to Microcampana. This genus has six radial tubes. Moreover, there exists on the apex of the bell, as in our Stomatoca, a prominent prolongation or projection never seen in Dipurena, its nearest ally.

There are many other Hydromedusæ in these waters, a notice of which would prolong this account beyond its limits. A huge Sphaeronectes, with a bell a quarter of an inch in diameter, a genus never seen before on this or on the Atlantic coast of the United States, a beautiful Physophore, Diphyes, and a host of others[1] were found.

On the return trip to Santa Barbara we sailed through a most extraordinary region of the channel in which there is a submarine petroleum well. The surface for a considerable distance is covered with oil, which oozes up from sources below the water, and its odor is very marked. The oil probably comes from the upturned asphaltic strata deep below the sea.

Near the oil well we sent down our dredge and brought up a most interesting Polyzoan, an account of which I have already published in the January number of the *Annals and Magazine of Natural History.* This animal has a jointed stem and an oval zooecium. When it first came on board I thought I had discovered a living Cystoid or Blastoid, as its shape was almost the same as that of some genera belonging to these types so familiar to the geologist, but now long extinct. In this, however, I was disappointed, although abundantly rewarded in finding a new genus of Polyozoa, Astrorhiza.

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[1] A full description of these animals with figures will soon be published by me.

The dredge also brought up great masses of a Retepora, which is called coral by the sailors in this locality, and are sometimes larger than a man's head. Innumerable other lower animals people these depths.

A fair but light wind brought us back to the wharf of Santa Barbara early in the evening of the day we left Prisoner's Harbor. We heard the sound of the evening bells of the Mission Church come down the side of the mesa, and as we threw our anchor the bright electric light of the city welcomed us home. The next morning a haze covered the base of the island of the Holy Cross, out of which rose the peak of Ragged Mountain like a monster from the sea. As the day wore on the fog lifted, and the soft African haze which gives the great charm to Santa Barbara ocean scenery took its place and the form of the beautiful island came out in all its extent, its outlines softened by the distance, and its dark cañons alternating with projecting headlands indistinguishable over the stretch of water which separates it from the mainland. The same island stands out clear in the beautiful light, unchanged since Cabrillo sailed up the channel for the first time fifty years after Columbus discovered the New World.

THE VEGETATION OF HOT SPRINGS.

BY WALTER HARVEY WEED.

THE vegetation of hot waters, though lowly organized and composed of obscure forms, is of considerable interest to all students of Nature, since the plants occur in very highly heated and mineralized waters under conditions that are fatal